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Long-term outcomes for cross-arch stabilizing bridges in periodontal maintenance patients – a retrospective study

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Abstract

Background: Cross-arch bridges are used to stabilize teeth for patients with reduced periodontal support. Little is known about technical or biological complications, whether teeth and implants can be combined in this type of bridge and the long-term effects on tooth loss.

Materials and methods: All patients treated in a specialist periodontal practice who received cross-arch stabilizing bridgework and were subsequently maintained for at least 7 years were included in the study. The patients were selected from all patients who underwent initial periodontal therapy after 1986 in a Norwegian periodontal practice. The bridges were assessed for biological and technical complications. Bridges retained by teeth or by a combination of teeth and implants were included in the study.

Results: Ninety-four rigid fixed bridges (77 teeth supported, 17 teeth and implant supported) in 80 patients (46 females, 34 males) were observed for an average of 10 years (range 7–22 years). In four patients, a bridge became loose and had to be re-cemented, and in one case the metal framework of a bridge fractured and the bridge had to be remade. In total, eight abutment teeth were lost from five patients but no implant abutments were lost. Overall, a higher rate of tooth loss was observed for patients provided with stabilizing bridges compared with control maintenance patients not treated with bridgework ($p < 0.0001$); however, the rates in both groups were very low.

Conclusion: Cross-arch stabilizing bridges constructed for periodontal patients as part of their periodontal maintenance therapy had few complications and were associated with low rates of abutment tooth loss. Combining teeth and implants did not affect the performance of these bridges.

Key words: implant failure; outcomes; periodontal disease; risk factors; stabilizing bridges; tooth loss

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The majority of patients who are treated for periodontal disease and adhere to a maintenance programme keep their teeth in the long term (Hirschfeld & Wasserman 1978, Fardal et al. 2004). However, these studies also show that a few patients continue to exhibit a progression of periodontitis in spite of treatment. Continued loss of periodontal support may result in increasing tooth mobility and impaired mastication (Johansson et al. 2006, Takeuchi & Yamamoto 2008) and ultimately tooth loss (Fardal & Linden 2008). Clinicians are often faced with difficult treatment decisions for such patients regarding the timing of the extraction and replacement of teeth and whether to stabilize the remaining teeth. Teeth with reduced periodontal support and a high degree of mobility are sometimes included in large stabilizing bridges in an attempt to prolong the functional lives of these teeth. It has been shown that a combination of periodontal therapy and extensive fixed prosthetic treatment in patients with advanced periodontal disease can result in stable periodontal conditions (Nyman & Lindhe 1979).

Conflict of Interest and Source of Funding Statement

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A number of complications, however, such as caries, tooth intrusion, endodontic problems, tooth or root fractures, tooth loss and metal or porcelain fractures have been described for large bridges (Raustia et al. 1998, Hammerle et al. 2000, Owall & Cronstrom 2000, Goodacre et al. 2003, Walton 2003).

Patients with a reduced dentition and a generalized advanced loss of periodontal support may in addition require implants to support large stabilizing bridges. However, controversies exist as to whether implants should be placed in patients with a history of periodontal disease (Hardt et al. 2002, Wennstrom et al. 2004, Roos-Jansåker et al. 2006, Karoussis et al. 2007, Fardal & Linden 2008) and if implants and teeth should be combined in a bridge construction (Hosny et al. 2000, Bragger et al. 2001, Naert et al. 2001, Block et al. 2002, Lang et al. 2004, Cordaro et al. 2005, Nickenig et al. 2006). Limited information is available about the long-term use of stabilizing bridges supported by teeth or by a combination of teeth and implants in patients at risk of further periodontal breakdown.

The aim of this study was to assess the long-term performance of stabilizing cross-arch bridges constructed as part of periodontal maintenance treatment. The outcomes measured were tooth loss and biological and technical complications of the bridges, which were constructed on teeth or a combination of teeth and implants. This study was one of a series, which aimed to develop internal quality control measures that could be applied to specialist periodontal practices (Fardal et al. 2001, 2002).

Materials and Methods

Study population

The records of all patients treated for periodontal disease by the principle investigator (Ø.F.) between 1986 and 2008 were screened for possible inclusion in the study. The investigator, a specialist certified by the Norwegian Department of Health and Social Services, is the only periodontal specialist in the area and works in two practice locations (Egersund and Flekkefjord). The specialist practice receives referrals from general dental practitioners, community dentists and physicians in Norwegian rural communities with a total population of 25–30,000. The area has approximately 25 dentists split evenly between private practice and the community dental service.

The following inclusion criteria were applied to identify cases with bridgework:

1. Initial periodontal therapy followed by maintenance therapy.
2. Construction of a cross-arch fixed bridgework by the referring dentist as part of the maintenance therapy.
3. Each bridge engaged at least the canine teeth bilaterally and had been in place for at least 7 years.
4. Bridges were constructed on teeth only or on a combination of teeth and implants.

Gender, date of birth, medical history including drug history at the time of the initial visit to the practice for diagnosis and treatment planning were obtained from the clinical records for all participants. At the initial visit, each participant was questioned in detail about whether close relatives (parents, children, brothers or sisters) had a history of periodontal disease. Unless the relative was a patient in the specialist office, the family history was not verified by examination of the relative. Smoking habits of all cases and controls were recorded in terms of the numbers of cigarettes smoked per day. Heavy smoking was equated to the consumption of 20 or more cigarettes per day. Patients who only smoked on social occasions were not classified as smokers. All the patients had been diagnosed initially as having chronic generalized mild, moderate or severe adult periodontitis. Probing depths were measured at six locations around each tooth. Periapical and bite wing radiographs were recorded. Patients with generalized moderate pocket depths (4–6 mm) and with radiographic proximal bone loss not exceeding 1/3 of the normal bone height were given the diagnosis of mild periodontitis. Patients with a mixture of moderate (4–6 mm) and deep pockets ($\geqslant$7 mm) and with generalized radiographic proximal bone loss of between 1/3 and 2/3 of the normal bone height were diagnosed as moderate periodontitis. Patients with deep pocket depths ($\geqslant$7 mm) and with proximal bone loss $>$2/3 of the normal bone height were diagnosed as severe periodontitis.

Periodontal treatment and maintenance

All those provided with bridgework completed a similar course of periodontal treatment. Initial therapy included oral hygiene instruction, scaling and root planing using standard curettes (Gracey and Colombia patterns). In addition, fine diamond finishing burs (Viking Dental, Waerhaug, Norway) were used to correct overhangs. In the initial phase, scaling and root planing were completed without the use of local anaesthesia. Periodontal surgery was prescribed for patients who had sites with bleeding on probing or persistent deep pocketing at reassessment 6 weeks after the completion of initial therapy. The periodontal surgery was carried out according to the principles of the modified Widman flap technique.

Following the completion of the initial definitive periodontal therapy, a prognosis of good, uncertain or poor, based on the clinical judgement of the periodontist (Ø.F.), was recorded for each patient. The prognosis took into account the periodontal support of the remaining teeth, healing after periodontal therapy, assessed level of plaque control, smoking habits, reported family history of periodontal disease and other systemic periodontal risk factors. Subsequently, all patients were seen between one and three times per year in the specialist practice for maintenance care. The maintenance visits with the specialist practitioner alternated with visits to the general dental practitioner such that all patients were seen in total between two and four times per year. Written instructions were given both to the referring dentist and the patient outlining the plans for maintenance therapy. During each maintenance visit, scaling and polishing of teeth was routinely performed according to the needs of each patient. Oral hygiene instruction and reinforcement were given as appropriate. Minor occlusal adjustments were performed as necessary. The interval between recall visits was shortened or lengthened as appropriate according to the stability of the periodontal condition. Re-treatment, defined as treatment over and above the prescribed maintenance, including the prescription of systemic antibiotics, non-surgical treatment or surgical treatment, was provided when judged necessary (Fardal & Linden 2005). The average levels of plaque control during maintenance (good, moderate, poor) as outlined by Fardal & Linden (2005) and compliance with the maintenance therapy (complete, erratic) were noted.

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Table 1. Characteristics of patients fitted with cross-arch stabilizing bridges

	All bridges ($n = 94$)	Teeth only as abutments ($n = 77$)	Teeth and implants as abutments ($n = 17$)
Age of patients at baseline (years)	50.1 (8.6)	49.6 (8.8)	51.8 (7.0)
Age of patients at bridge insertion (years)	55.5 (7.0)	55.3 (7.2)	55.6 (6.3)
Observation of bridge (years since inserted)	10.2 (3.1)	10.2 (3.1)	10.1 (3.1)
Number of teeth at baseline	22.1 (4.7)	23.1 (4.0)	17.7 (5.0)
Total number of abutments	7.9 (2.0)	7.8 (2.1)	8.0 (1.2)
Tooth abutments	7.3 (2.4)	7.8 (2.1)	4.8 (1.8)
Implant abutments	0.6 (1.4)	–	3.2 (1.4)
Number of pontics	2.4 (1.4)	2.3 (1.5)	2.8 (1.2)
Number of teeth at final observation	18.3 (5.1)	19.5 (4.6)	12.7 (3.8)

Numerical data as mean (standard deviation).

Bridge construction and follow-up

The decision to recommend stabilizing bridges was based on the fact that the maintenance therapy had not been successful in stabilizing the periodontal condition, and in the majority of cases there was further tooth loss. The designs of the bridges were based on the numbers of teeth remaining, the periodontal status of the teeth and whether strategic implants could be placed. All bridges were designed with rigid components, no stress-breakers and were cemented. In the majority of cases, there was an observation period of several years between the initial periodontal therapy and bridge construction. This allowed the clinician to assess whether any changes in the periodontal condition were associated with increasing tooth mobility. The number of teeth at the initial examination, the number of teeth lost between the initial examination and the final assessment, bridge(s) observation in years, the number of implants and mobile teeth included as bridge abutments were recorded.

Technical problems with the bridge frameworks during the observation period were identified. Biological complications affecting the teeth or implants used as abutments including the reasons for the loss of the abutment teeth were recorded.

Subjects with bridgework were compared with a control group of age- and gender-matched patients who attended the specialist practice for treatment and maintenance over the same period and who did not have bridgework constructed. The control group was identified from the practice database.

Statistical analysis

Descriptive statistics are presented as means and standard deviations. Student's *t*-test was used for data that were normally distributed; otherwise, the Mann–Whitney *U*-test was applied. χ^2 analysis was used for categorical data. The level of significance was set at $p < 0.05$.

Results

Eighty patients (46 females, 34 males) fulfilled the inclusion criteria. They were referred by 20 general dentists and one prosthodontist who subsequently constructed the bridges. The average age of the patients at the initial examination was 50.1 (SD 8.6, range 29–69) years (Table 1). Nineteen patients had cardiovascular disease, three had diabetes, two had osteoporosis and one patient reported long-term treatment with antidepressants. There were 25 patients (31%) who had close relatives with periodontal disease and 22 (28%) who had spouses with periodontal disease. Sixty patients (75%) smoked and consumed on average 14.5 (range 5–25) cigarettes per day. All patients who smoked were encouraged to stop. If they were unable to stop, help was suggested in terms of various cessation programmes. Data on the success of this approach were not collected for this population. Following treatment, 77 patients (96%) were compliant with the maintenance programme whereas three showed erratic compliance. Plaque control was rated as good in 16 (20%), moderate in 50 (63%) and poor in 14 (18%) patients.

There were 1789 teeth at the initial examination (average 22.4, SD 4.6, range 8–30). During the observation period, 307 teeth were lost and 73 (91%) patients lost at least one tooth. The mean number of teeth lost per patient was 3.8 (SD 3.4, range 0–18) teeth. This was significantly greater ($p < 0.0001$) than the mean value 0.6 (SD 1.2) in a group ($n = 66$) of control maintenance patients not treated with bridgework drawn from the practice database. Those with bridgework were significantly more likely to be smokers ($p < 0.001$), to have reported a family history of periodontitis ($p = 0.01$) and to have had a poorer standard of plaque control ($p = 0.04$) than controls.

The bridges were made in a few cases as an integral part of the definitive periodontal treatment, but in other patients up to 15 years after completion of the periodontal therapy (Table 1). Sixty-six patients (83%) had a bridge in one jaw (56 maxillary, 10 mandibular) whereas 14 (17%) had a bridge in both jaws. There were 77 tooth-supported bridges and 17 bridges supported by a combination of both teeth and implants (Table 1). Patients who were provided with bridges retained by a combination of teeth and implants had significantly fewer ($p < 0.0001$) teeth at baseline than those who received bridges with only teeth as abutments (Table 1).

The bridges had on average 10.3 (SD 2.3, range 6–15) units. The distribution of tooth abutments, implant abutments, mobile teeth at time of bridge construction and pontic units are shown in Tables 2 and 3. The upper canines were the most frequent abutments while the upper premolars were the teeth most frequently replaced. The ratio of tooth abutments to pontic units was 3.33 for the teeth-supported bridges and 2.89 for bridges supported by both teeth and implants. Mobility of at least grade 2 was present in 138 (20%) of the teeth included as abutments. The ratio of non-mobile to mobile abutments for bridges supported by teeth only was 5.38 whereas for the bridges supported by both teeth and implants, it was 5.23. Twenty-nine bridges (31%) had poster-

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Table 2. Distribution of tooth abutments, pontic units and tooth mobility (before bridge insertion) for 77 cross-arch stabilizing bridges supported by teeth only

Upper jaw	*n*														
Tooth abutments	450	11	22	22	31	53	47	44	43	37	52	33	23	23	9
Pontic units	119	0	7	19	14	0	6	10	11	17	1	13	16	3	2
Mobility	92	0	2	3	7	2	15	18	17	12	1	8	4	3	0
		7	6	5	4	3	2	1	1	2	3	4	5	6	7
Tooth abutments	153	2	2	12	15	20	16	11	7	15	22	19	9	2	1
Pontic units	62	0	3	2	3	3	7	11	15	7	0	0	7	4	0
Mobility	20	0	3	1	1	3	2	2	1	1	4	2	0	0	0
Lower jaw	n														

Table 3. Distribution of tooth and implant abutments, pontic units and tooth mobility (before bridge insertion) for 17 cross-arch stabilizing bridges supported by a combination of teeth and implants

Upper jaw	*n*														
Tooth abutments	72	0	3	0	1	10	8	12	9	7	8	6	4	4	0
Pontic units	38	0	1	11	1	0	2	0	2	4	3	6	5	3	0
Implant abutments	48	0	0	2	11	6	5	5	3	5	6	4	1	0	0
Mobility	26	0	0	0	1	3	1	5	4	4	5	2	1	0	0
		7	6	5	4	3	2	1	1	2	3	4	5	6	7
Tooth abutments	10	1	0	0	0	2	1	1	0	1	2	0	0	1	1
Pontic units	9	0	2	1	1	0	0	1	2	0	0	0	2	0	0
Implant abutments	6	0	0	1	1	0	1	0	1	0	2	0	0	0	0
Mobility	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lower jaw	*n*														

ior cantilever extensions, 13 unilaterally and 16 bilaterally (45 in total). Thirty-three were opposed by natural teeth, crowns or pontics, one was opposed by a complete denture whereas the remainder were non-opposed.

Biological complications

The average observation period for the bridges was 10.2 (SD 3.1, range 7–22) years. During this period, eight abutment teeth were lost (range 1–3) in five patients, seven due to caries and one due to endodontic complications. In one patient, who had three abutment teeth removed due to caries, the bridge was sectioned and the teeth that had been extracted were replaced with a partial denture. In the other four patients who lost the abutment teeth, appropriate treatment facilitated their bridges remaining in service. Endodontic therapy was required for four teeth and a further eight abutment teeth developed caries. During the observation period, 53 patients (66%) required re-treatment over and above the routine maintenance therapy. Two patients who experienced periodontal abscess formation, which in one case involved multiple abscesses, were managed by appropriate re-treatment. Generalized severe gingival recession developed in four patients including one who experienced this related to bridges in both jaws. In other cases, there was gingival recession associated with bridge abutments that was evident on examination but did not cause concern to the patients. Implants were placed in 17 patients and three of these patients were treated for peri-implantitits during the observation period but none of the implants were lost.

Technical complications

Technical problems affected seven bridges during the observation period. In two cases, there was a fracture of the porcelain, which was judged minor by the patients and did not cause concern. In four cases, the bridgework became loose and had to be removed and recemented. In the remaining case, the metal framework of the bridge fractured after 6 years in service and the bridge had to be remade.

Discussion

The main finding of the present study was that provision of extensive stabilizing fixed bridges on teeth with reduced periodontal support is a successful treatment modality in patients treated for periodontal disease and enrolled in an adequate maintenance care programme. The results of the present study thus confirm the findings of previous studies, for example Nyman & Lindhe (1979). Combining teeth and implants as abutments did not affect the performance of these bridges.

The decision to recommend stabilizing bridges was based on the number of teeth remaining, the periodontal status of the teeth and whether strategic implants could be placed**.** The final decision to construct the bridges was made between the referring dentist, the patient and the periodontist. In the majority of cases, conventional periodontal therapy with maintenance treatment was not adequate to stabilize the dentitions for the patients resulting in continued tooth loss. Among the patients treated with bridgework, a much higher proportion than the controls had risk factors for periodontitis, such as close relatives with a history of periodontal disease (Fardal & Linden 2008), increased prevalence of smoking, tooth loss (Fardal et al. 2004, Hughes et al. 2006) and worse plaque control (Axelsson & Lindhe 1981, Axelsson et al. 2004, Carnevale et al. 2007). The patients who eventually were treated with bridgework may, therefore, have been a subgroup with different risk factor profile within the population of patients referred for specialist periodontal management.

Biological complications involving abutment teeth were low. The rate of abutment tooth loss was lower than for the loss of other teeth, not incorporated in the bridgework. This is in contrast to the findings of Pretzl et al. (2008) who reported that teeth used as abutments had an increased risk of being lost following periodontal therapy. However, this study did not specifically report on cross-arch stabilizing bridges and comparisons are thus difficult. A systematic review by Lulic et al. (2007) reporting on stabilizing bridges for patients with reduced periodontal support found the same high success rates as the present study. The levels of caries and endodontic problems in the present study were less than those reported in other studies (see review Goodacre et al. 2003). The great majority of the bridges replaced anterior teeth in the upper arch and incorporated principally single-rooted teeth including the canines. Most studies have identified the highest rates of tooth loss due to progressive periodontitis in multirooted teeth

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(Hirschfeld & Wasserman 1978, Fardal et al. 2004). In the present study, the teeth most frequently replaced by the bridgework were the upper premolars, which were most likely of the anterior teeth to have proved difficult to stabilize.

One reason for the high success rate of cross-arch stabilizing bridges in the present study may have been the high compliance with the maintenance therapy. Virtually all (95%) of bridge patients showed good compliance. The maintenance therapy was active and consisted of several visits to both the referring dentist and the periodontist every year. In addition, the re-treatment rate of the patients who were treated with bridgework was much higher than previous reports from the same clinical setting (Fardal et al. 2004, Fardal & Linden 2005). The high level of re-treatment is suggestive of unstable periodontal conditions. However, the active intervention seemed to help stabilize the periodontal conditions for the abutment teeth at least for the duration of the study.

Large cross-arch stabilizing bridges may be challenging for dentists to construct. It is therefore interesting to observe that almost all the bridges in this study were constructed by general dental practitioners. Technical complications were low in the present study, and in all but two cases the complications were managed by modifications to the bridges, which allowed them to continue in function. One reason for the low complication rate in the present study could be the favourable abutment to pontic ratio, which was substantially greater than that reported in a 10-year retrospective study (Napankangas et al. 1997). However, this was judged necessary because the proportion of mobile teeth included in the bridges was high.

A significant proportion (31%) of the bridges in the present study included uni- or bilateral distal cantilevers. No more complications were noted for these bridges than the bridges without distal cantilevers. This is in contrast to the findings of a systematic review by Pjetursson et al. (2007), where a lower survival rate for cantilever bridges was reported.

There were no differences in the performance of the bridges between those retained by teeth and those retained by a combination of teeth and implants for any of the outcomes investigated. The low complication rate is in agreement with the findings of Cordaro et al. (2005) who reported a 99% survival rate of complete arch fixed bridges connecting teeth and implant abutments in patients with normal and reduced periodontal support. However, other studies have reported a lower success rate for bridges retained by both teeth and implants (Hosny et al. 2000, Bragger et al. 2001, Naert et al. 2001, Block et al. 2002, Lang et al. 2004, Nickenig et al. 2006, Pjetursson et al. 2007). Tooth intrusions were not observed when teeth were used in combination with implants as abutments. This contradicts findings in several previous studies (Naert et al. 2001, Block et al. 2002, Lang et al. 2004, Cordaro et al. 2005). These studies reported intrusions in conjunction with non-rigid attachments. In the present study, only rigid connections without stress-breakers were used, which may explain the difference.

In conclusion, within the limitations of the current study, cross-arch stabilizing bridges in patients treated for periodontal disease in a Norwegian specialist practice who complied with a strict maintenance programme, had a high survival rate. After a 10-year observation period, 98% of bridges remained in function and there were low rates of biological and technical complications. Combining teeth and implants as abutments in these bridges did not affect their 10-year survival.

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Clinical Relevance

Scientific rational for the study: Teeth with reduced periodontal support and increased mobility are sometimes included in large stabilizing bridges in an attempt to prolong the functional lives of these teeth. Limited information is available about the long-term use of stabilizing bridges supported by teeth or by a combination of teeth and implants in periodontal patients. The aim of this study was to assess the long-term performance of stabilizing cross-arch bridges constructed as part of the periodontal maintenance treatment.

Principle findings: Ninety-four cross-arch bridges in 80 patients were observed for an average of 10 years (range 7–22 years). There were few complications associated with these bridges and combining teeth and implants did not affect the outcome. The rate of tooth loss was low for these bridges.

Practical implications: Large cross-arch stabilizing bridges made for patients with continuing periodontal breakdown as part of the maintenance therapy seem to be a good alternative to multiple extractions and implant replacements.

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